# Welcome to EF5 Training

University of Oklahoma/HyDROS

Module 1.1

# Outline – Day 1

## WELCOME

- Goals
- System requirements
- What are EF5 and CREST?
- Contents and organization of training course
- Introduction to OU, HyDROS, and NASA-SERVIR
- Installing QGIS and TauDEM

## INTRODUCTION TO HYDROLOGICAL MODELS

## EF5 OVERVIEW

## DEM DERIVATIVES

# Goals of Training Course

**Locate and process forcing data**

Rainfall, potential evapotranspiration

**Locate and process digital elevation models (DEMs) and create derivatives**

Diagnose problems — Develop workflow

**Run EF5 and learn customization options**

Batch files, control files

**Interpretation and analysis of model results**

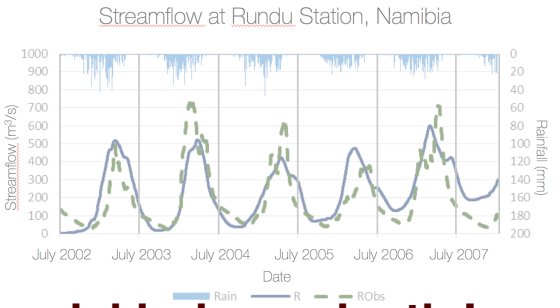
Flood forecasting — Drought monitoring

Confidence and uncertainty

**Improving model results**

Manual calibration — Meaning of parameters

Automatic calibration — Evaluation of model skill




**Give you the ability to set-up, run, calibrate, and use the model independently!**

# System Requirements

**Personal computer with Windows 7, 8, or 8.1**

**Administrator privileges for installing software**

**~4 gigabytes disk space**

QGIS requires 1.2 GB

.NET Framework 3.5 SP1 requires 500 MB

The training course file package is around 2GB

**Microsoft Excel, Word, and PowerPoint**

# System Requirements

**Both 32-bit and 64-bit versions of EF5 are available**

`ef5_32.exe`
`ef5_64.exe`

**32-bit and 64-bit versions of QGIS are also included in the `software` folder**

Choose your version based on the version of Microsoft Windows on your computer

`QGIS-OSGeo4W-2.6.1-1-Setup-x86_64.exe`
`QGIS-OSGeo4W-2.6.1-1-Setup-x86.exe`

**TauDEM will install and run on either 32- or 64-bit operating systems**

**Internet access is desirable but is only required when installing TauDEM on a computer not already equipped with .NET Framework 3.5**

# What are EF5 and CREST?

## EF5 stands for Ensemble Framework for Flash Flood Forecasting

It is scalable to different resolutions

EF5 can forecast the entire continuum of floods

## EF5 is not a single hydrologic model – it is a framework for hydrologic modeling

Multiple model cores and physics schemes are possible

## CREST stands for Coupled Routing and Excess Storage

CREST is a hydrologic model developed by NASA (National Aeronautics and Space Administration) and OU (the University of Oklahoma)

CREST-like model physics are part of EF5

# What are EF5 and CREST?

## Multi-model ensemble

Expandable with new models and physics

Multiple solutions → an idea of uncertainty in a forecast

## User-friendly

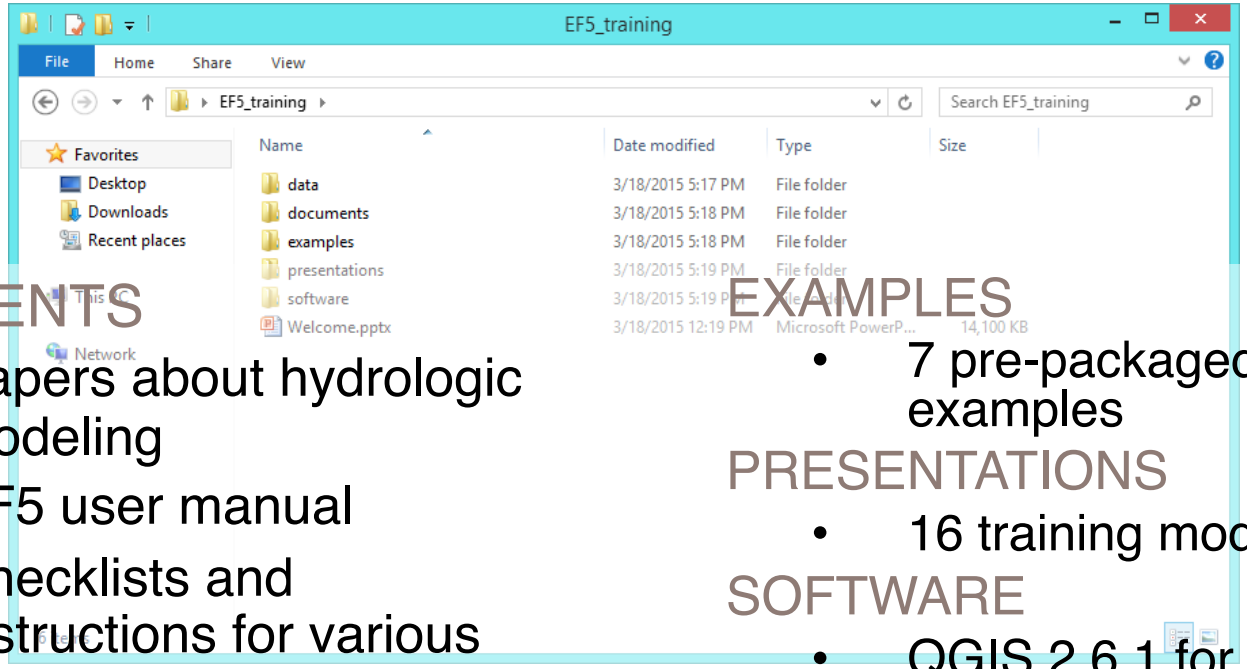
## Cross-platform

Windows, Linux, Mac OS X

## Flexible precipitation inputs

TRMM, MRMS, Stage IV

# Contents of Training Course




## DOCUMENTS

- Papers about hydrologic modeling
- EF5 user manual
- Checklists and instructions for various course components

## DATA

- Precipitation/PET forcing
- HydroSHEDS DEM

## EXAMPLES

- 7 pre-packaged EF5 examples

## PRESENTATIONS

- 16 training modules

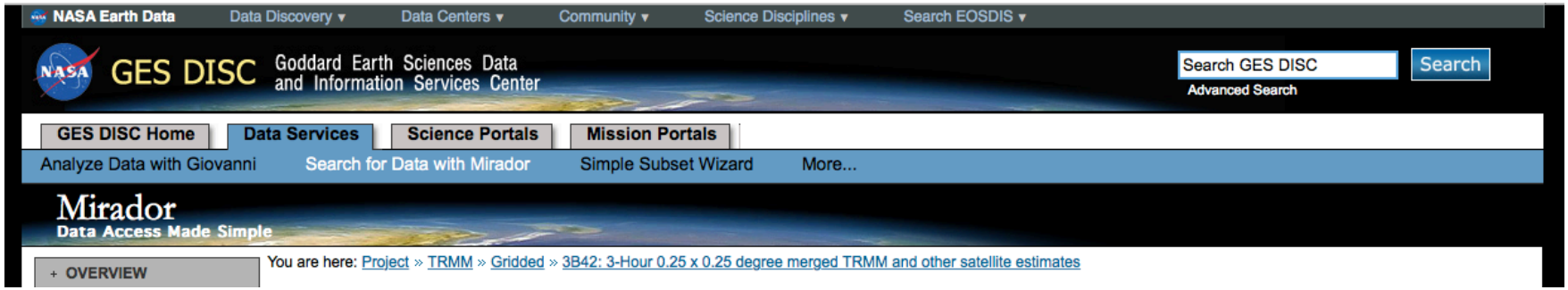
## SOFTWARE

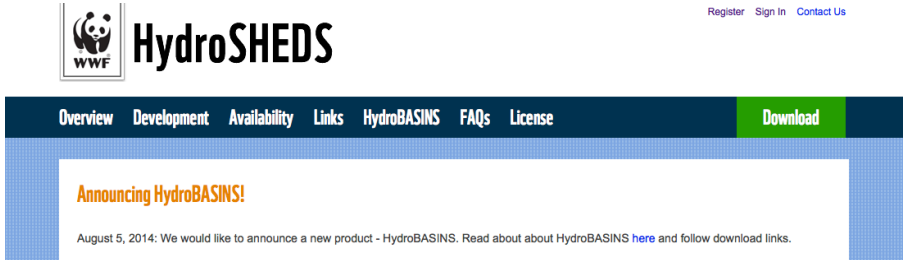
- QGIS 2.6.1 for 64-bit Windows
- QGIS 2.6.1 for 32-bit Windows
- TauDEM 5.2
- EF5 for 32-bit Windows
- EF5 for 64-bit Windows

# Contents of Training Course

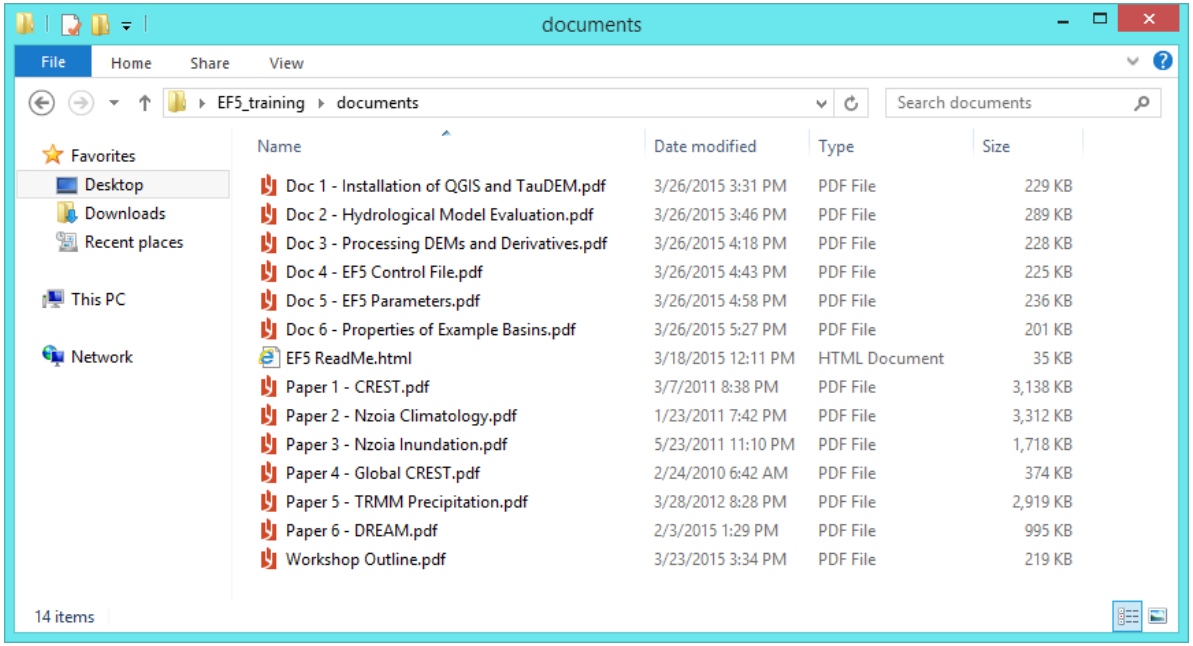
## DATA

- PET – Monthly potential evapotranspiration from FewsNET
- Precipitation – 3-hrly global precipitation estimates from NASA Tropical Rainfall Measurement Mission
- HydroSHEDS – Hydrological data and maps based on shuttle elevation derivatives at multiple scales
- Observations – Observed stream flow for training examples



# Contents of Training Course

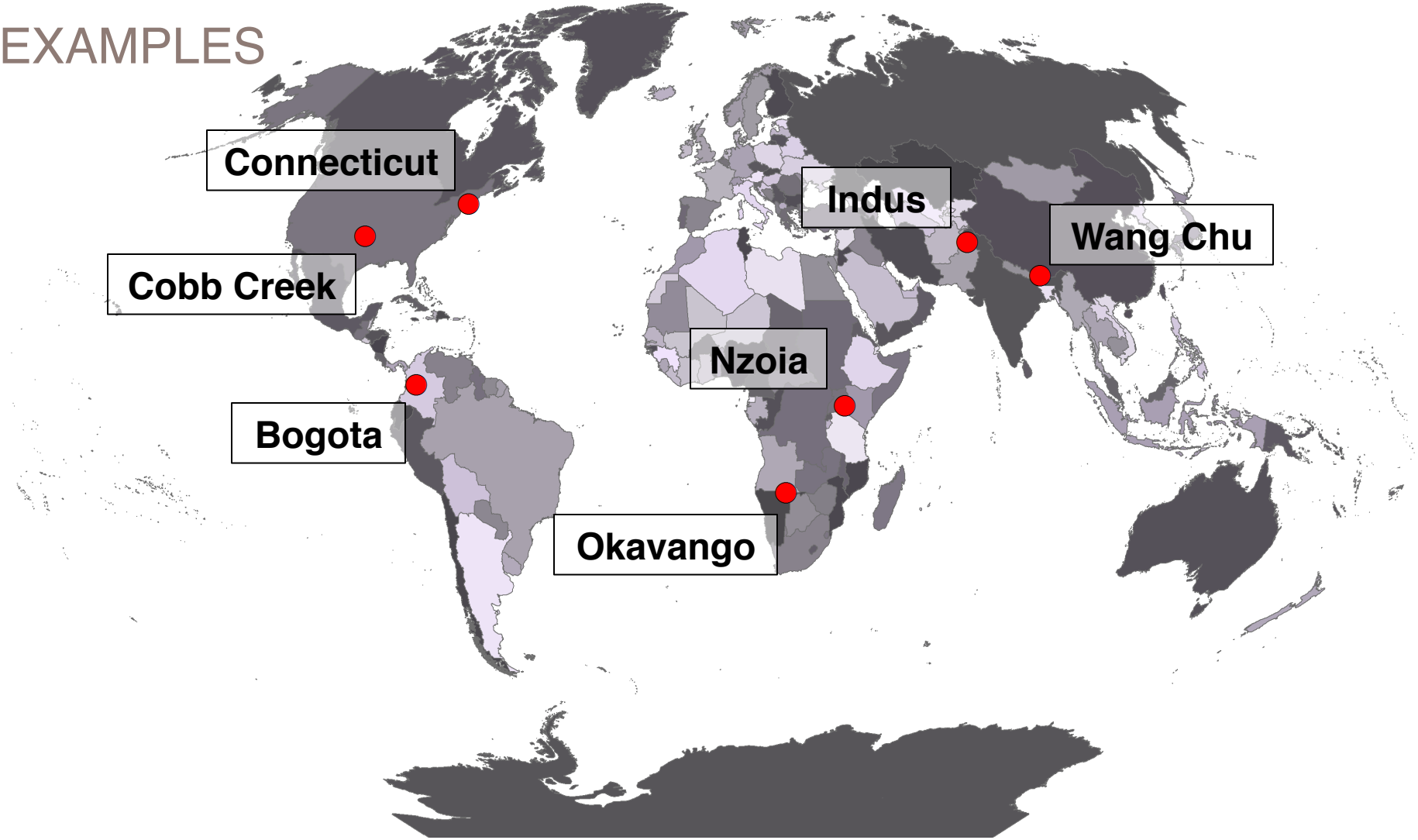

documents
File
Home
Share
View
EF5_training
documents
Search documents
Favorites
Desktop
Downloads
Recent places
This PC
Network
Name
Date modified
Type
Size
Doc 1 - Installation of QGIS and TauDEM.pdf 3/26/2015 3:31 PM PDF File 229 KB
Doc 2 - Hydrological Model Evaluation.pdf 3/26/2015 3:46 PM PDF File 289 KB
Doc 3 - Processing DEMs and Derivatives.pdf 3/26/2015 4:18 PM PDF File 228 KB
Doc 4 - EF5 Control File.pdf 3/26/2015 4:43 PM PDF File 225 KB
Doc 5 - EF5 Parameters.pdf 3/26/2015 4:58 PM PDF File 236 KB
Doc 6 - Properties of Example Basins.pdf 3/26/2015 5:27 PM PDF File 201 KB
EF5 ReadMe.html 3/18/2015 12:11 PM HTML Document 35 KB
Paper 1 - CREST.pdf 3/7/2011 8:38 PM PDF File 3,138 KB
Paper 2 - Nzoia Climatology.pdf 1/23/2011 7:42 PM PDF File 3,312 KB
Paper 3 - Nzoia Inundation.pdf 5/23/2011 11:10 PM PDF File 1,718 KB
Paper 4 - Global CREST.pdf 2/24/2010 6:42 AM PDF File 374 KB
Paper 5 - TRMM Precipitation.pdf 3/28/2012 8:28 PM PDF File 2,919 KB
Paper 6 - DREAM.pdf 2/3/2015 1:29 PM PDF File 995 KB
Workshop Outline.pdf 3/23/2015 3:34 PM PDF File 219 KB
14 items

## DOCUMENTS

- Workshop Outline
- EF5 ReadMe
- 6 Quick Guides/Checklists
  - Installing QGIS and TauDEM
  - Hydrological Model Evaluation
  - Processing DEMs and Derivatives
  - EF5 Control File
  - EF5 Parameters
  - Properties of Example Basins
- 6 Scientific Papers
  - CREST physics, DREAM calibration, TRMM precipitation, and examples of CREST in use

# Contents of Training Course

## EXAMPLES

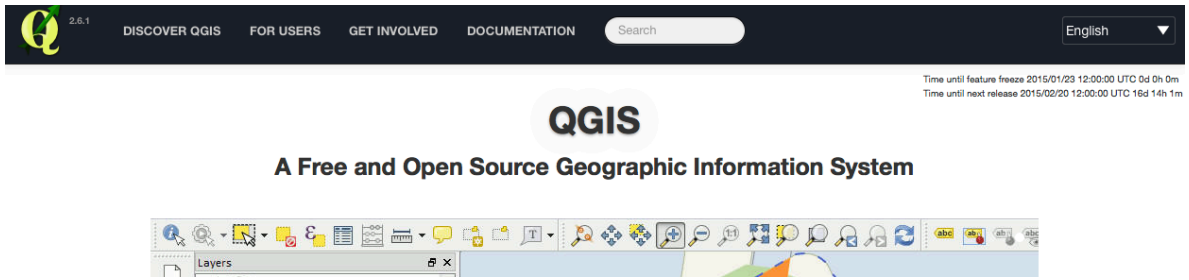


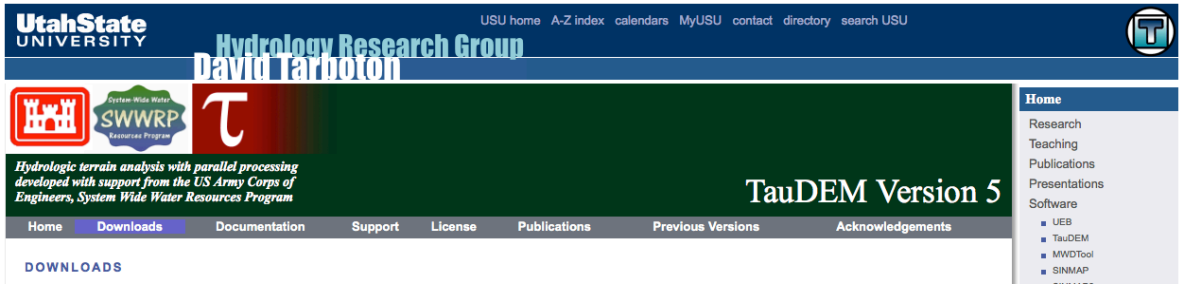
# Contents of Training Course

## PRESENTATIONS

- Day 1
  - Welcome
  - Introduction to Hydrological Models
  - EF5 Overview
  - DEM Derivatives
- Day 2
  - Rainfall and PET
  - Manual Calibration
  - Automatic Calibration
  - Interpreting and Using Model Output
- Day 3
  - DEM Practice
  - Calibration Practice
  - Drought
  - Cobb Creek Example
- Day 4
  - Connecticut River Example
  - Bogota River Example
  - Create Your Own Example (or Indus River Example)
  - Conclusions and Wrap-Up

# Contents of Training Course



## SOFTWARE

- Quantum GIS (QGIS)
  - Standalone installer of version 2.6.1 for 64-bit Windows
  - Version 2.6.1 32-bit installer also included
- TauDEM
  - Version 5.1.2 self-extracting zip file install package
- EF5
  - Version 0.2 Windows-compiled executable file for 32-bit systems
  - Version 0.2 Windows-compiled executable file for 64-bit systems

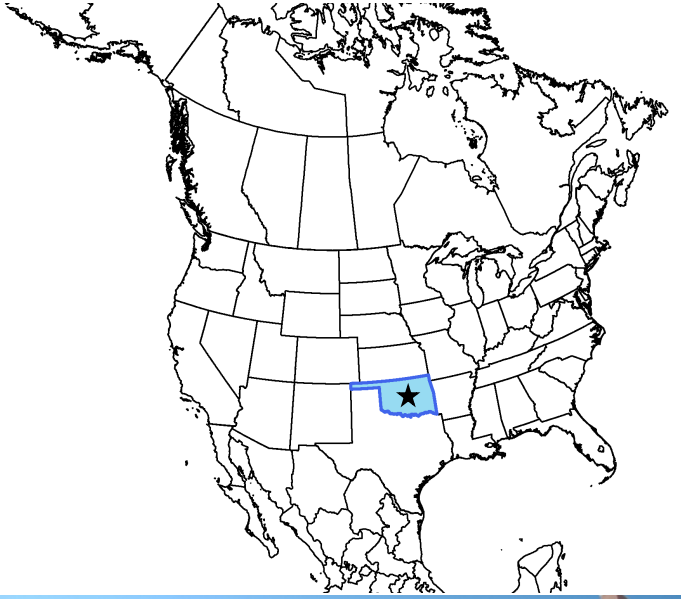
# Introduction to OU

**Norman, Oklahoma**

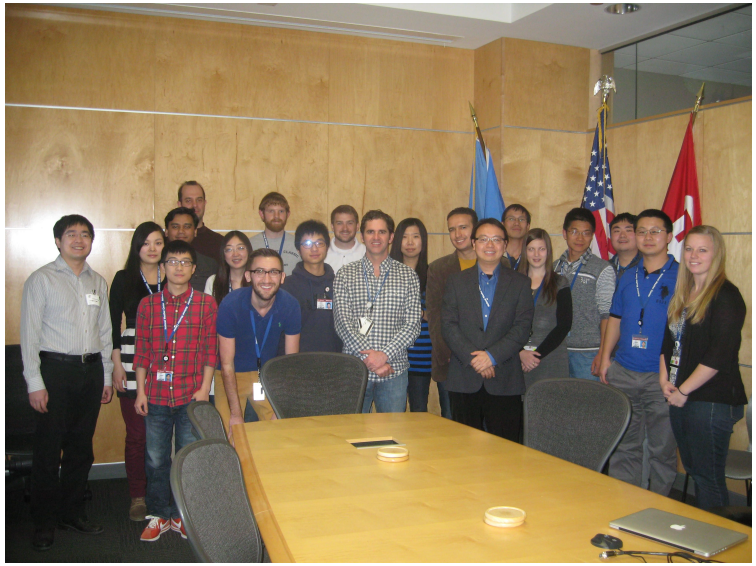
**Nearly 30,000 students**

**Home to the National Weather Center (600 meteorologists and hydrologists):**

- National Severe Storms Laboratory
- School of Meteorology
- Advanced Radar Research Center
- Hydrometeorology and Remote Sensing Laboratory (HyDROS)



# HyDROS Laboratory



5 scientists and faculty

9 post-docs and visitors

15 graduate students

Several dozen alumni

From all over the world!

## QPE – QUANTITATIVE PRECIPITATION ESTIMATES

- Merging satellite, rain gauges, and weather radars
- Expertise with PERSIANN, CMORPH, TRMM, MRMS
- Improvements to ground radar and satellite estimates

## HYDROLOGIC MODELING

- EF5
- CREST
- HyPRO
- Data assimilation
- Coupling with snow models and landslide models
- Global, regional, and local modeling

## FLASH (FLOODED LOCATIONS AND SIMULATED HYDROGRAPHS) PROJECT

- Suite of flash flood forecasting tools in United States
- Includes hydrologic models and other rainfall-driven tools

# NASA-SERVIR

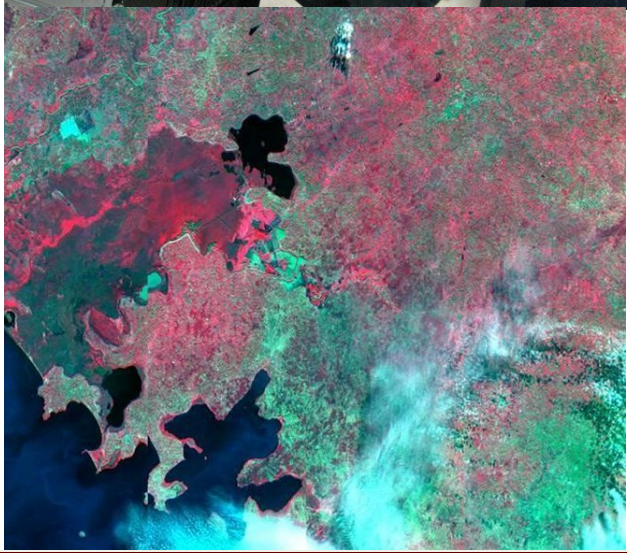
## SERVIR is a joint venture between NASA and USAID (United States Agency for International Development)

- Satellite-based observation data
- Science applications
- Improve environmental decision making in developing nations

## Centers throughout the world

- Marshall Space Flight Center in Huntsville, Alabama
- CATHALAC in Panama
- RCMRD in Kenya
- ICIMOD in Nepal

## Floods, fires, droughts, frost

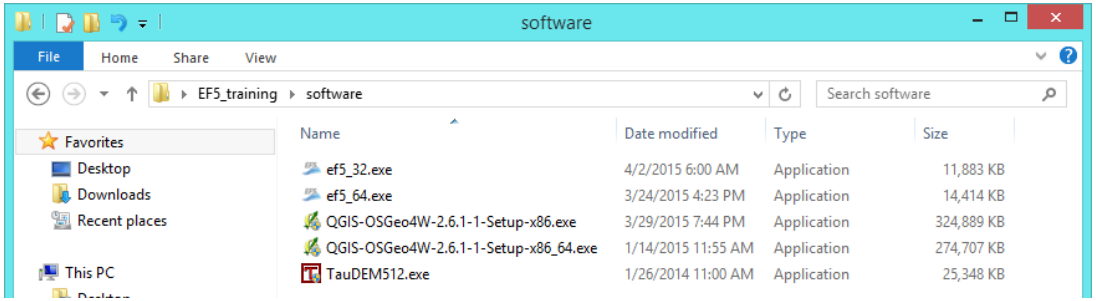


Installing equipment at RCMRD (photo: RCMRD)
Satellite image of Lake Victoria basin from EO-1, 2008 (photo: NASA/EO-1)

# QGIS Installation

**Start by moving your `EF5_training` folder to your `Desktop`**

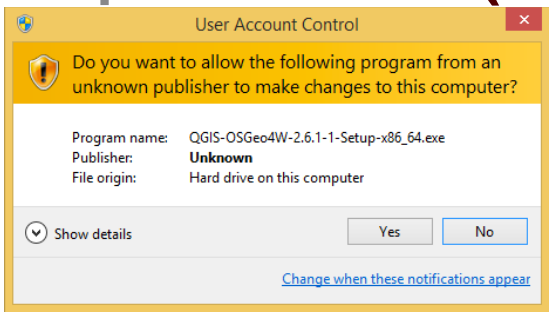
**Navigate to the `EF5_training\software` folder**




**Select `QGIS-OSGeo4W-2.6.1-1-Setup-x86_64.exe` (for computers with 64-bit Windows)**

**Select `QGIS-OSGeo4W-2.6.1-1-Setup-x86.exe` (for computers with 32-bit Windows)**

**Answer "Yes" at the prompt →**


User Account Control
Do you want to allow the following program from an unknown publisher to make changes to this computer?
Program name: QGIS-OSGeo4W-2.6.1-1-Setup-x86_64.exe
Publisher: Unknown
File origin: Hard drive on this computer
Show details
Yes
No
Change when these notifications appear

# QGIS Installation

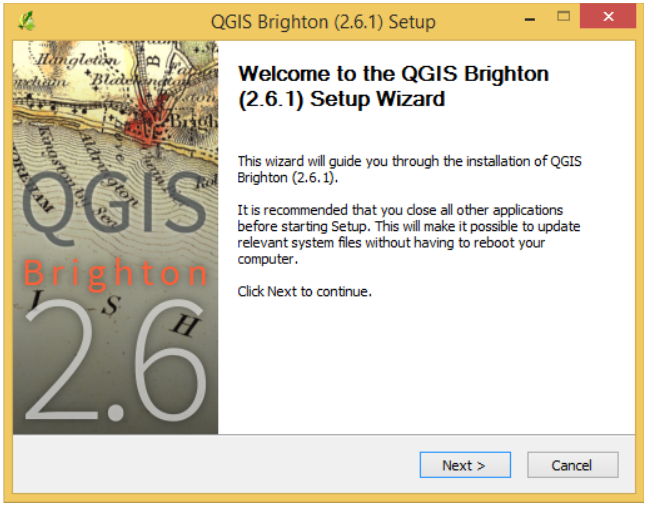
**"Welcome to the QGIS Brighton (2.6.1) Setup Wizard"**

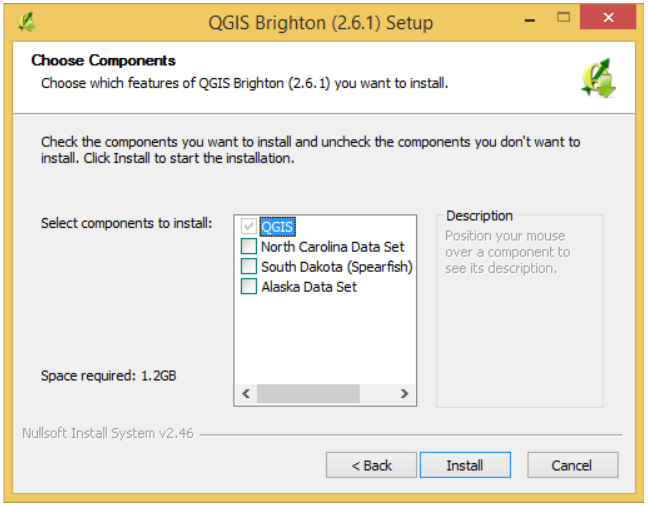
**Click "Next"**

**Agree to the license terms – "I Agree"**

**"Choose Install Location" – `C:\Program Files\QGIS Brighton` is fine – click "Next"**

**"Choose Components" – only install "QGIS" – click "Install"**


QGIS Brighton (2.6.1) Setup
Welcome to the QGIS Brighton (2.6.1) Setup Wizard
This wizard will guide you through the installation of QGIS Brighton (2.6.1).
It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.
Click Next to continue.
QGIS
Brighton
2.6
Next >
Cancel


QGIS Brighton (2.6.1) Setup
Choose Components
Choose which features of QGIS Brighton (2.6.1) you want to install.
Check the components you want to install and uncheck the components you don't want to install. Click Install to start the installation.
Select components to install:
QGIS
North Carolina Data Set
South Dakota (Spearfish)
Alaska Data Set
Description
Position your mouse over a component to see its description.
Space required: 1.2GB
Nullsoft Install System v2.46
< Back
Install
Cancel

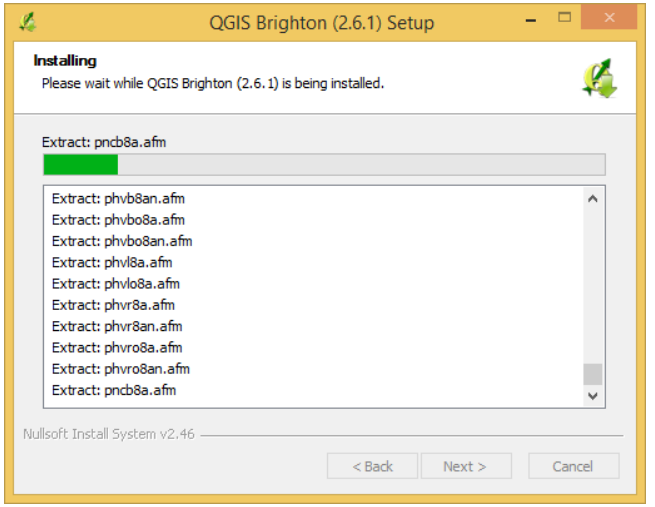
# QGIS Installation

**This process should take 2-3 minutes – click “Finish”**

**You’ll now see six icons on your Desktop**

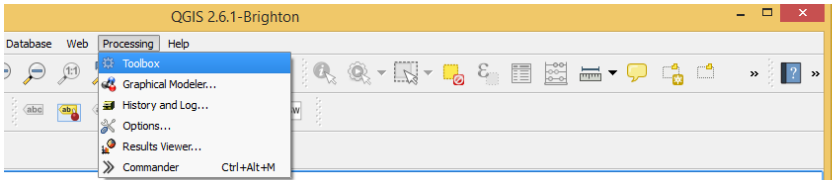
**We’ll be using `QGIS Desktop 2.6.1`**

**Go ahead and open it – exit the tip window when it appears**

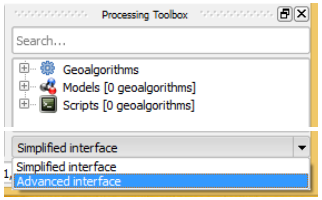


# QGIS Installation

**In the “Processing” menu, select “Toolbox” and a new window pane will appear in the right side of QGIS**

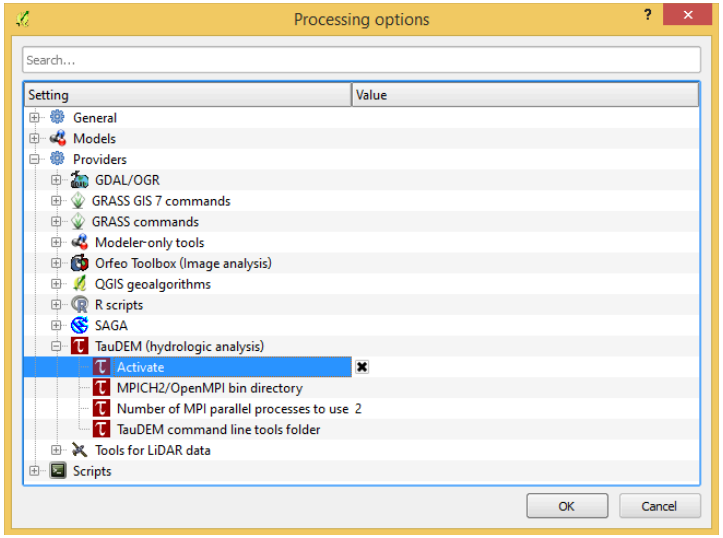



**At the bottom of the “Processing Toolbox” select “Advanced interface”**




**In the “Processing” menu select “Options…”**

**Navigate to Providers -> TauDEM (hydrologic analysis) and check “Activate”**

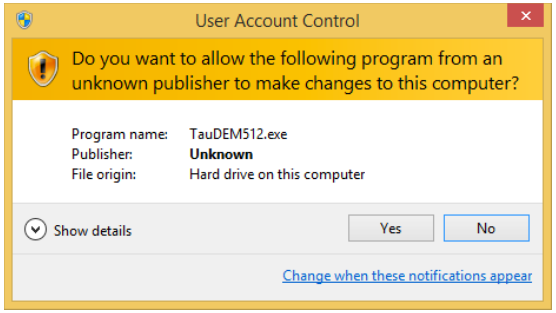


# TauDEM Installation

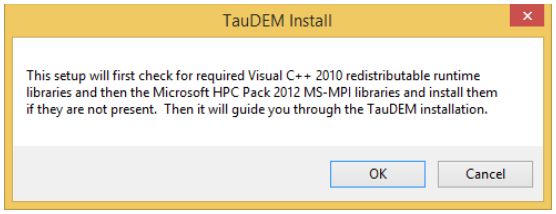
**Now it's time to install TauDEM**

**Navigate to `\EF5_Training\software` and open `TauDEM512.exe`**

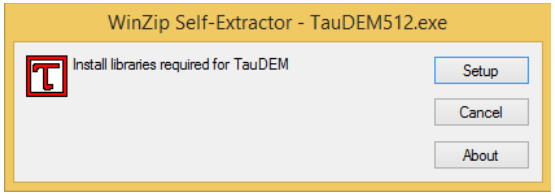
**Answer "Yes" to the UAC prompt**


User Account Control
Do you want to allow the following program from an unknown publisher to make changes to this computer?
Program name: TauDEM512.exe
Publisher: Unknown
File origin: Hard drive on this computer
Show details
Yes
No
Change when these notifications appear

**Select "OK" at TauDEM Install**


TauDEM Install
This setup will first check for required Visual C++ 2010 redistributable runtime libraries and then the Microsoft HPC Pack 2012 MS-MPI libraries and install them if they are not present. Then it will guide you through the TauDEM installation.
OK
Cancel

**Select "Setup" and then TauDEM will begin either the Microsoft Visual C++ 2010 x86 installation or the Microsoft HPC Pack 2012 MS-MPI installation**

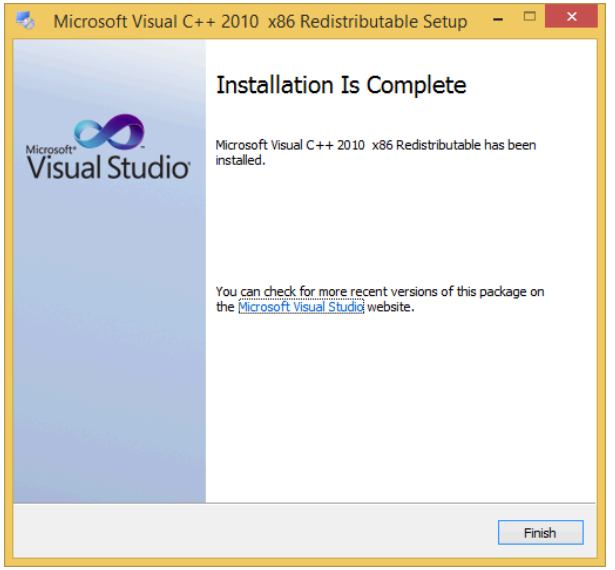


# TauDEM Installation

## If Microsoft Visual Studio has to be installed (if not, skip below to the HPC Pack 2012 installation):

Click “Setup” and then accept the license terms

Click “Install” and then “Finish”

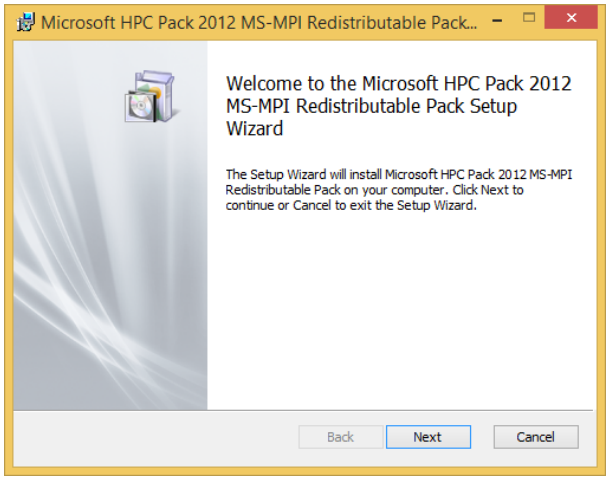

Microsoft Visual C++ 2010 x86 Redistributable Setup
Installation Is Complete
Microsoft Visual Studio
Microsoft Visual C++ 2010 x86 Redistributable has been installed.
You can check for more recent versions of this package on the Microsoft Visual Studio website.
Finish

## The Microsoft HPC Pack 2012 installer will automatically pop up:

Click “Next” and the accept the license terms

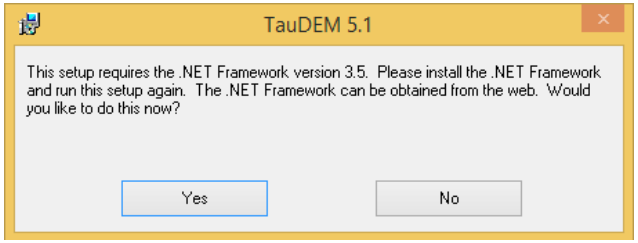
The default location is fine

Click “Install”


Microsoft HPC Pack 2012 MS-MPI Redistributable Pack...
Welcome to the Microsoft HPC Pack 2012 MS-MPI Redistributable Pack Setup Wizard
The Setup Wizard will install Microsoft HPC Pack 2012 MS-MPI Redistributable Pack on your computer. Click Next to continue or Cancel to exit the Setup Wizard.
Back
Next
Cancel

# TauDEM Installation

## Now you may need to install the .NET Framework version 3.5


TauDEM 5.1
This setup requires the .NET Framework version 3.5. Please install the .NET Framework and run this setup again. The .NET Framework can be obtained from the web. Would you like to do this now?
Yes
No

If you get this dialog box, click “Yes”

Otherwise, skip ahead to Slide 28

Select .NET Framework 3.5 SP1 on the website that pops up

### .NET Framework and .NET SDKs

The .NET Framework is the easiest way to build apps on the Microsoft platform. You can download Visual Studio Express for free, and be coding in just a few minutes. You can also use the .NET SDKs and targeting packs to build apps for a given Microsoft platform, such as Microsoft Azure.

**.NET Framework Downloads**

- .NET Framework 4.6 Preview
- .NET Framework 4.5.1
- .NET Framework 4.0
- .NET Framework 3.5 SP1

**Visual Studio Express (free)**

- Windows 8
- Windows Desktop
- Windows Phone
- Web and Azure

**.NET SDK Downloads**

- Visual Studio 2013
- Visual Studio 2012
- Visual Studio 2010

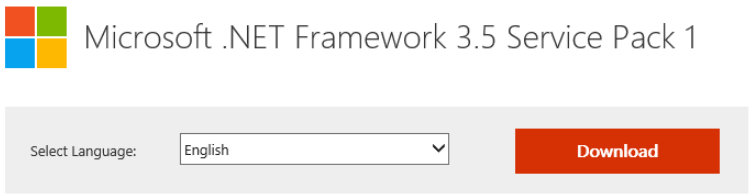
**Team blogs and social**

- .NET | @dotnet | Facebook
- ASP.NET | @aspnet | Facebook
- EF | @ef | Facebook

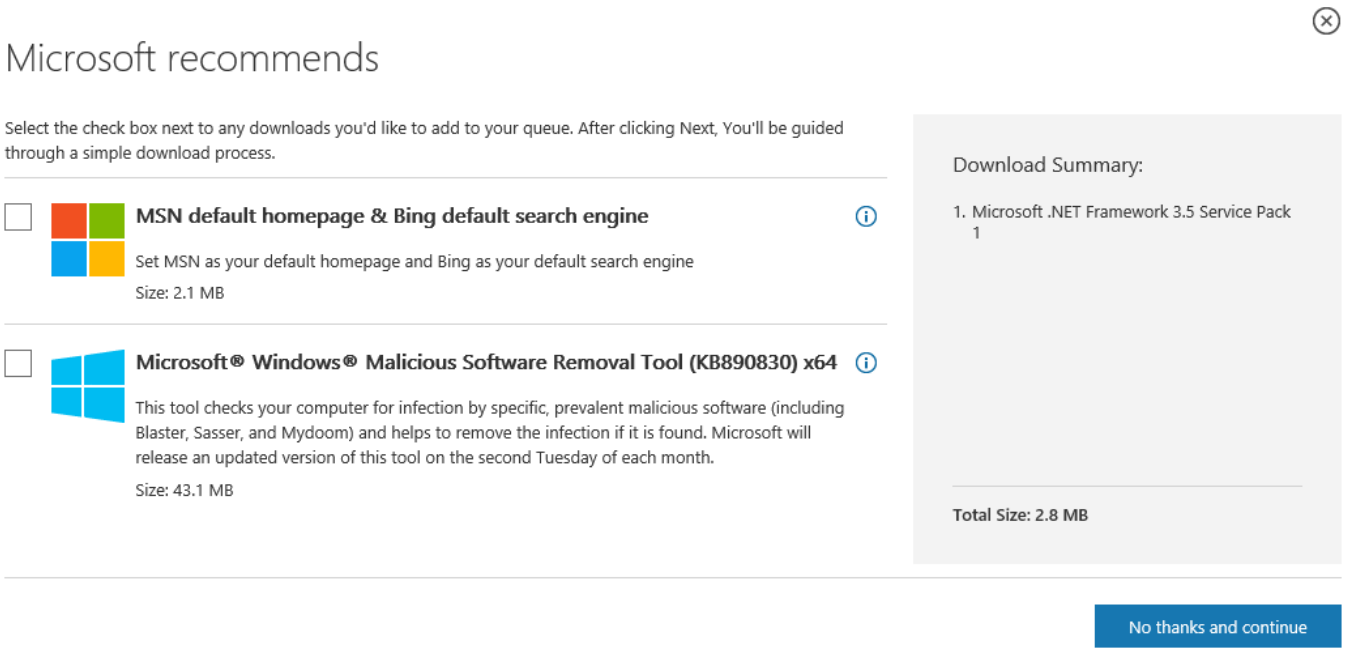
**Get Help**

# .NET Framework 3.5 Installation

## Click the red “Download” button

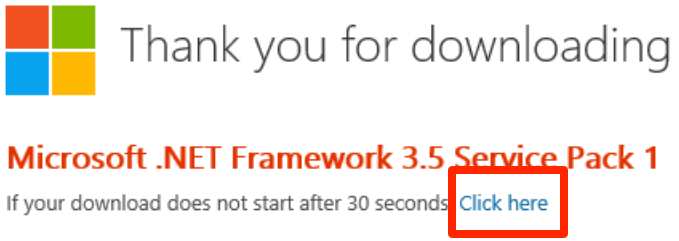



## Then click “No thanks and continue”

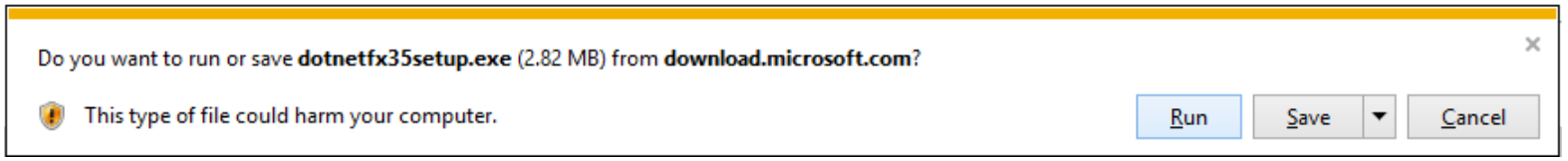

Microsoft recommends
Select the check box next to any downloads you'd like to add to your queue. After clicking Next, You'll be guided through a simple download process.
MSN default homepage & Bing default search engine
Set MSN as your default homepage and Bing as your default search engine
Size: 2.1 MB
Microsoft® Windows® Malicious Software Removal Tool (KB890830) x64
This tool checks your computer for infection by specific, prevalent malicious software (including Blaster, Sasser, and Mydoom) and helps to remove the infection if it is found. Microsoft will release an updated version of this tool on the second Tuesday of each month.
Size: 43.1 MB
Download Summary:
1. Microsoft .NET Framework 3.5 Service Pack 1
Total Size: 2.8 MB
No thanks and continue

# .NET Framework 3.5 Installation

**Click the boxed link (at right) →**

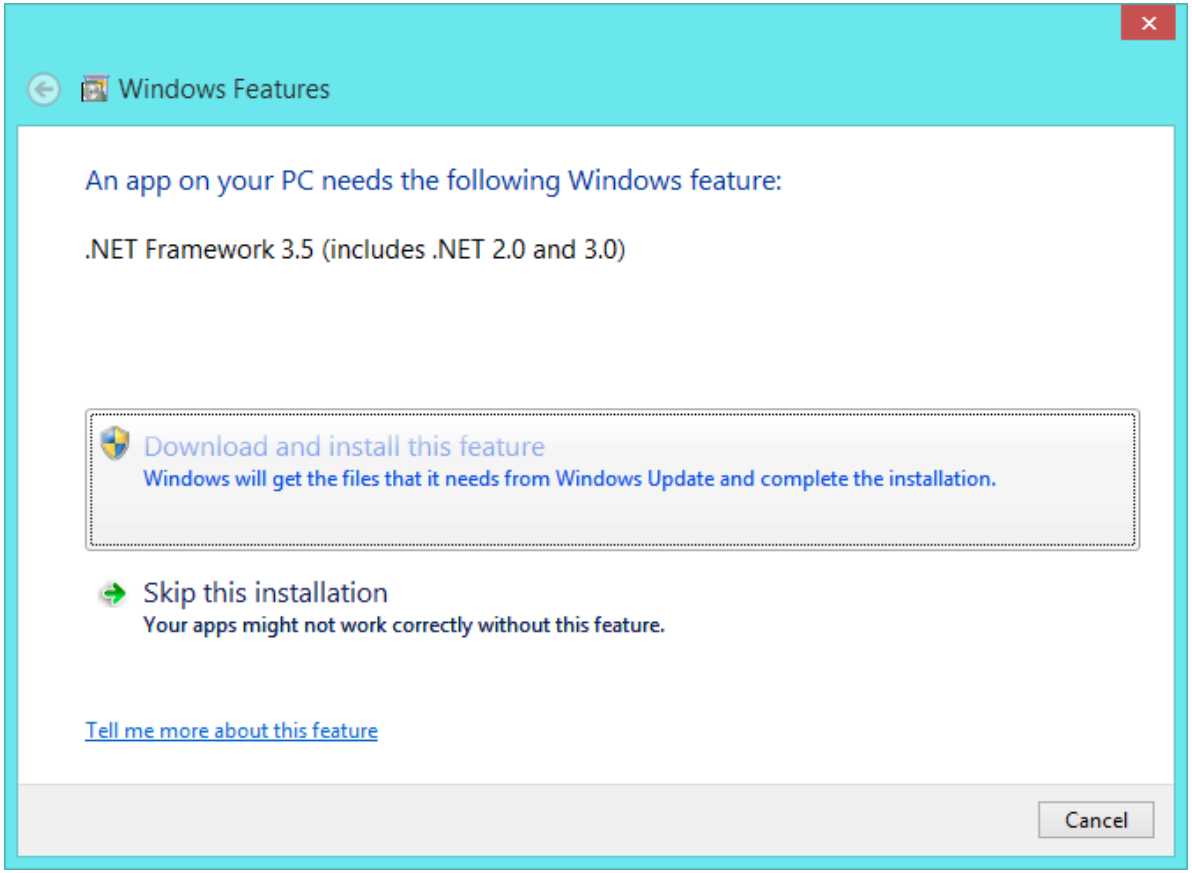

Thank you for downloading
Microsoft .NET Framework 3.5 Service Pack 1
If your download does not start after 30 seconds Click here

**Then click "Run" at the bottom of the browser window**


Do you want to run or save dotnetfx35setup.exe (2.82 MB) from download.microsoft.com?
This type of file could harm your computer.
Run
Save
Cancel

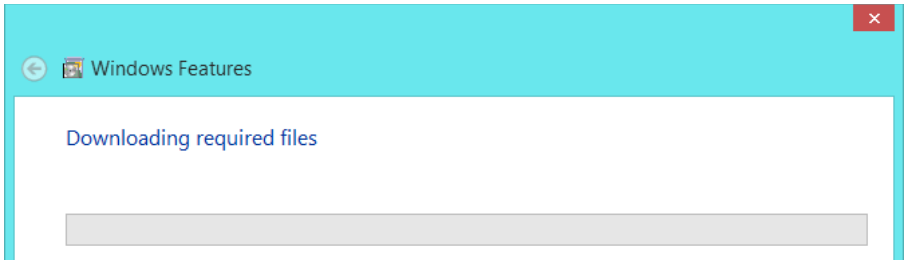
# .NET Framework 3.5 Installation

## At the “Windows Features” pop-up, click “Download and install this feature”


Windows Features
An app on your PC needs the following Windows feature:
.NET Framework 3.5 (includes .NET 2.0 and 3.0)
Download and install this feature
Windows will get the files that it needs from Windows Update and complete the installation.
Skip this installation
Your apps might not work correctly without this feature.
Tell me more about this feature
Cancel

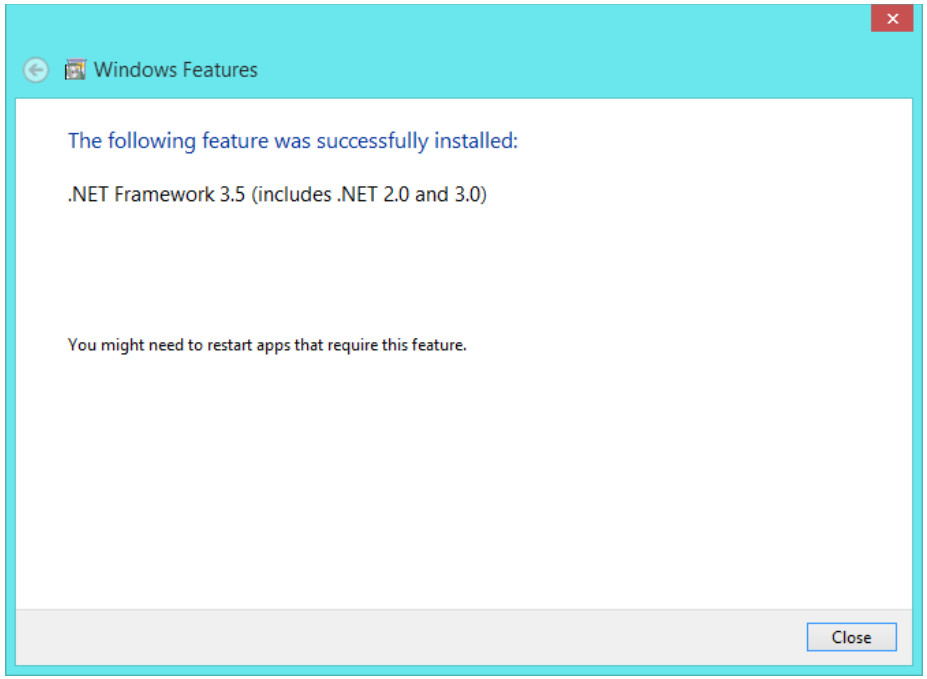
# .NET Framework 3.5 Installation

**Windows will download the required files (this process may take a significant amount of time, depending on your internet connection)**




**Then click "Close" →**

**Reopen `TauDEM512.exe`**


Windows Features
The following feature was successfully installed:
.NET Framework 3.5 (includes .NET 2.0 and 3.0)
You might need to restart apps that require this feature.
Close

# TauDEM Installation

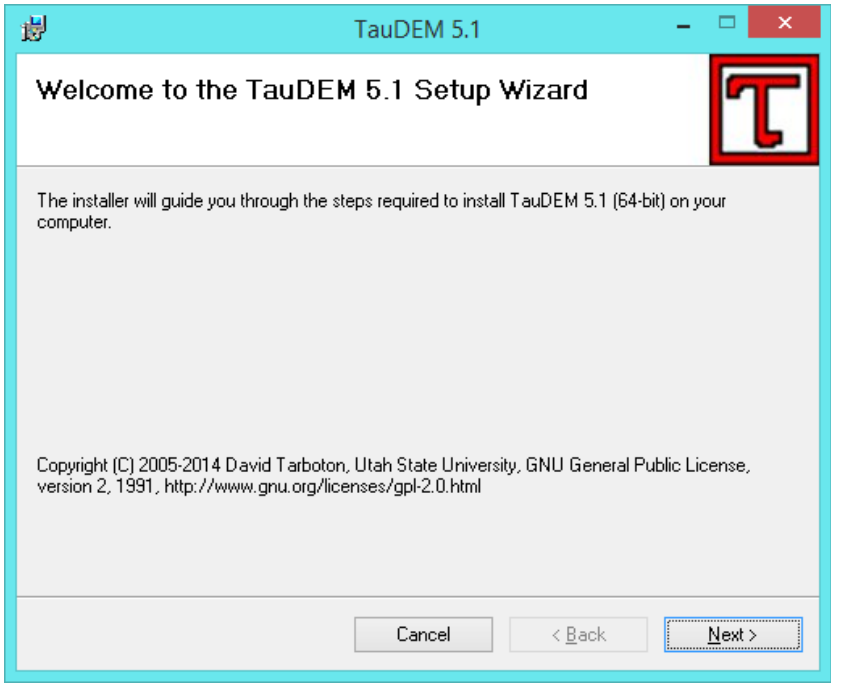
**Click “Next”**

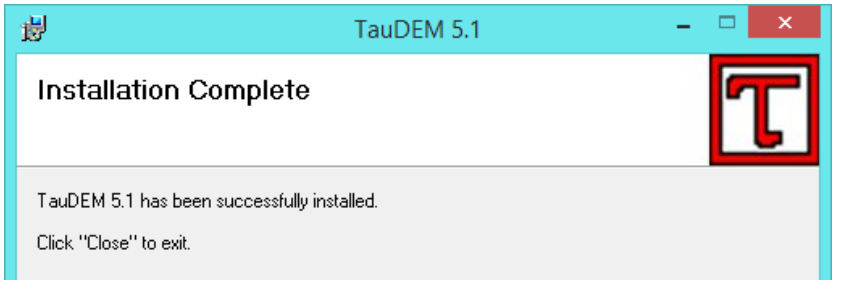
**The default location is fine**

**At “Confirm Installation”, click “Next”**

**Congratulations – TauDEM has been successfully installed!**

**Click “Close” to exit**


TauDEM 5.1
Welcome to the TauDEM 5.1 Setup Wizard
The installer will guide you through the steps required to install TauDEM 5.1 (64-bit) on your computer.
Copyright (C) 2005-2014 David Tarboton, Utah State University, GNU General Public License, version 2, 1991, http://www.gnu.org/licenses/gpl-2.0.html
Cancel
< Back
Next >



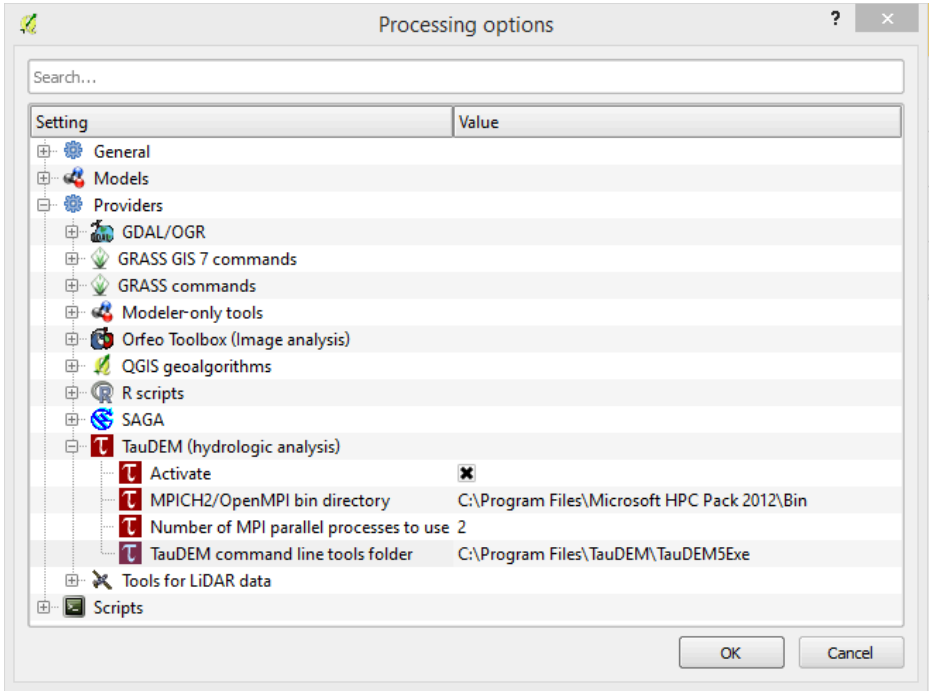
# QGIS/TauDEM Configuration

**Now return to QGIS and select "Options…" from the "Processing" menu**

**Navigate to "Providers" and "TauDEM (hydrologic analysis)"**

**Type `C:\Program Files\Microsoft HPC Pack 2012\Bin` next to "MPICH2/ OpenMPI bin directory"**

**Type `C:\Program Files\TauDEM\TauDEM5Exe` next to "TauDEM command line tools folder"**

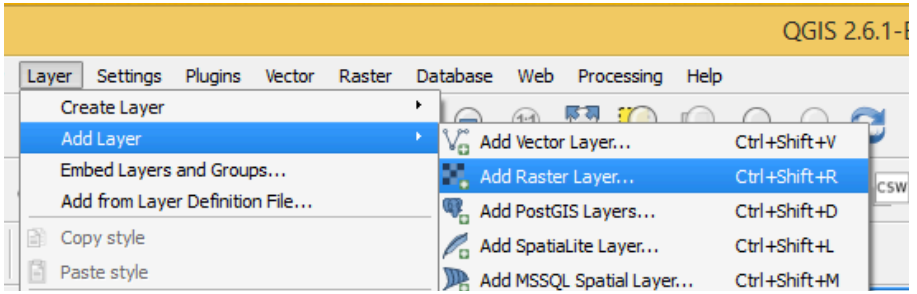



**Make sure QGIS saves this setting by clicking somewhere else inside the "Processing options" dialog**

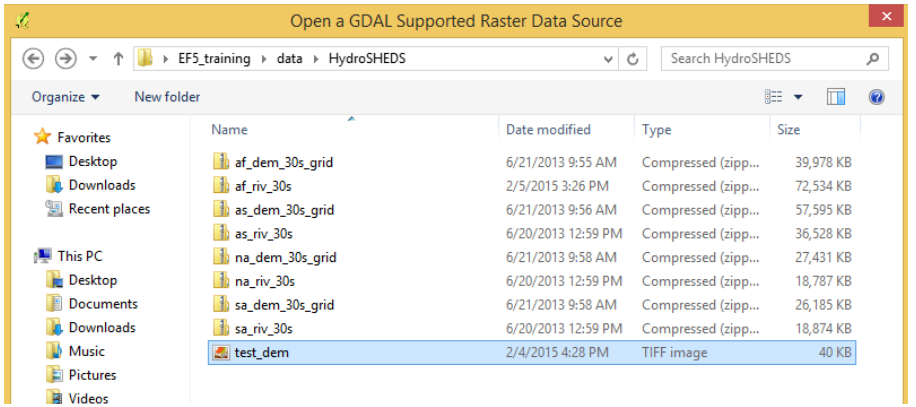
**Click "OK"**

# Test Configuration

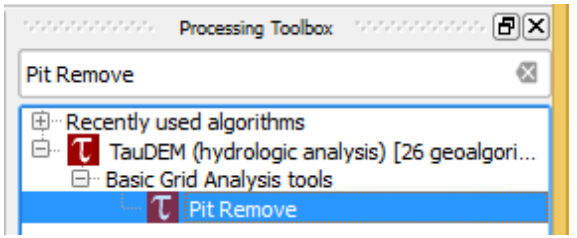
**Navigate to QGIS's "Layer" menu, "Add Layer" and "Add Raster Layer…"**




**In the dialog box, go to `\EF5_training\data\HydroSHEDS` and open "test_dem.tif"**

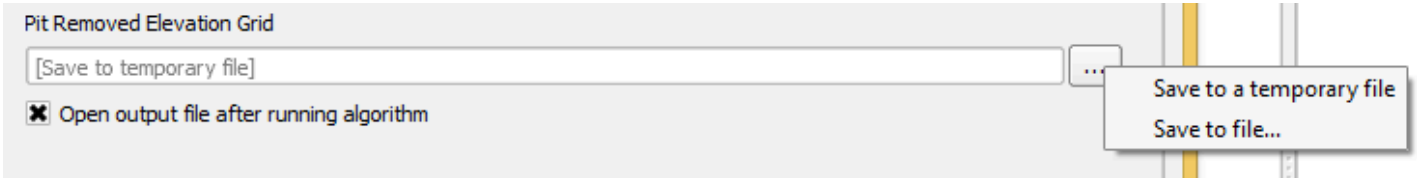



**In the "Processing Toolbox", search for "Pit Remove" and double-click**



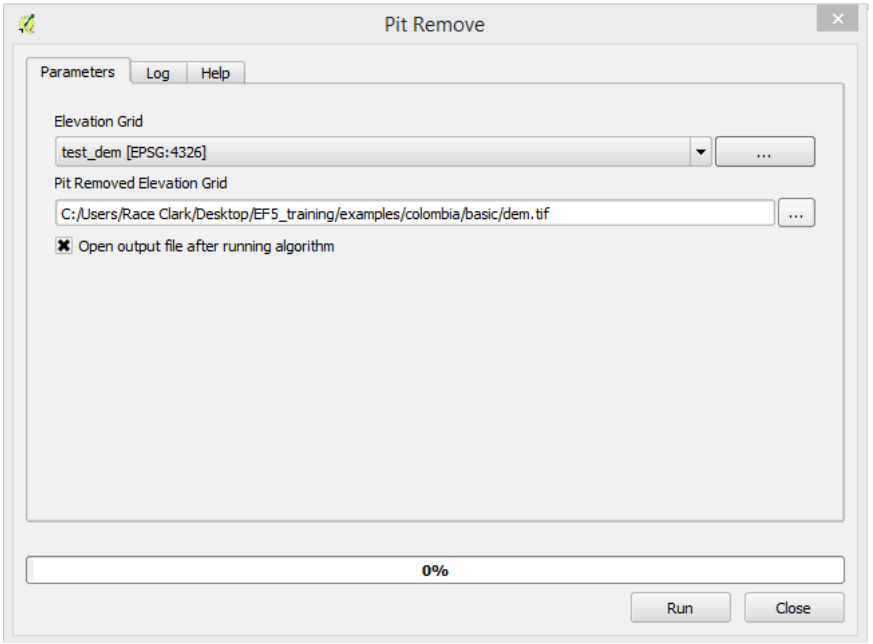
# Test Configuration

**In the "Pit Remove" dialog box, select "test_dem" as your "Elevation Grid" and for "Pit Removed Elevation Grid" click "Save to file…"**




**Save the grid to**
`\EF5_training\examples\colombia\basic\dem.tif`

**Now click "Run"**



# Test Configuration

QGIS should now have two maps in the central window: “test_dem” and “Pit Removed Elevation Grid”

If you received an error when running Pit Remove, something went wrong in the installation process

Check the file paths in the “Processing” menu “Options…” dialog

You can also try rerunning the TauDEM installer to see if something went wrong the first time

# Why QGIS and TauDEM?

## QGIS is flexible

- Literally thousands of available plug-ins exist
- QGIS runs on Windows, Mac, Linux, and other systems
- ArcGIS runs only on Windows

## QGIS is free and open-source

- It costs you nothing and has a community of thousands of users and supporters
- Commercial solutions like Esri's ArcGIS cost thousands of dollars per workstation
- Commercial support for QGIS is available from third parties

QGIS is licensed under the Creative Commons Attribution-ShareAlike 3.0 license.

www.qgis.org

TauDEM was developed by David Tarboton of Utah State University with support from the US Army Corps of Engineers System Wide Water Resources Program. TauDEM is available under the terms of GNU General Public License v2.

hydrology.usu.edu/taudem/taudem5/index.html

# Coming Up….

**The next module is**

INTRODUCTION TO HYDROLOGICAL MODELS

**You can find it in your `\EF5_training\presentations` directory**

**Module 1.1 References**

EF5 Training Doc 1 – Installation of QGIS and TauDEM, (March 2015).